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A Study on the Impact Character of Adhesive Bonded Denture Acrylic Resin Joints

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In this paper we describe an experimental study. Studied in this article is resistance against impact load applied to bonded part of dental hot curing type acrylic resin teeth in oral cavity, acrylic resin base, etc.

As a result of the research of test and experiments, it is found that; Scattering in impact values of adhered materials was little. Impact strength increased as temperature of atmosphere rose. Approximation of adhesion joint efficiency in terms of impact strength was 70% and 40% with hot and cold curing types acrylic resin respectively, and hot curing type adhesive was superior.

Observation by scanning type electron microscope revealed that impact fracture of the base material and that of the material adhered by hot curing type adhesive were similar and that the breaking was ductile, the failure of the material adhered by cold curing type adhesive was accompanying breaking-away on adhesion interfact.

1. INTRODUCTION

Testing method to find out toughness and brittleness of the material by applying momentary impact load to the material and measuring the energy used for causing failure is called impact test. From this, it may be said that impact strength shows lower limit of resistance of the material against momentary concentrated load.[1)~4)] Studied in this article is resistance against impact load applied to bonded part of resin teeth in oral cavity, resin base, etc. Namely, resistance characteristics against impact load of dental P.M.M.A. bonded by

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P.M.M.A. of hot and cold curing type are measured and observed by Charpy tester and scanning type electron microscope.

2. EXPERIMENTAL MATERIALS AND EXPERIMENTAL METHOD

Base material used in this experiment was dental acrylic resin of hot curing type, which was heat- and pressure-molded in 100°C under 100kg/cm^2 for 45 minutes, thence naturally cooled in the metal mold. Specimens of JIS-1 type as shown in Fig.1 were made of the base material by a miller. Fig.2 shows specimen used for bonding test, from which it is noted that end of V-notch was so finished as to closely touch bonding interface. Bonding was performed by butt joint with 1mm root gap by adhesives of hot and cold curing type P.M.M.A.s; the former adhesive was heat cured in 100°C for 45 minutes, while the latter adhesive was cured in 20°C for 60 minutes. Impact test was carried out in a manner as to cause percussion failure by hammering the back of notch at the center of the specimen supported at the both ends. Total impact energy absorbed in causing failure was devided by original sectional area of notch part and this is called Charpy impact value in this article. Testing machine used in this experiment was a Charpy impact tester of 0.8kg-m capacity made by Shimazu Seisakusho Ltd. In consideration of possible temperature range in oral cavity, impact test was carried out under comparatively wet condition (15 minutes in water) and in temperature ranging from 0°C to 80°C. Observation of impact fracture by scanning type electron microscope was conducted with the base material, the material adhered by hot curing type adhesive and the

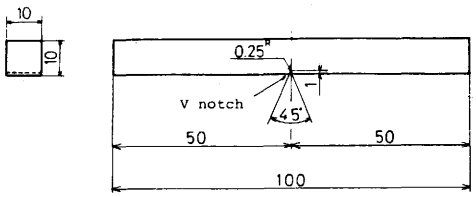


Fig.1 Specimen of Charpy impact test for dental P.M.M.A. base material (JIS No.1 type).

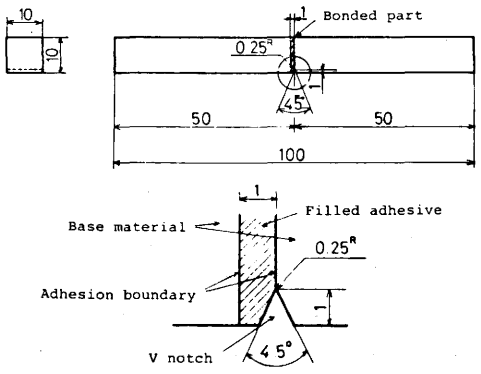


Fig.2 Specimen of Charpy impact test for adhesion bonded dental P.M.M.A. (JIS No.1 type).

material adhered by cold curing type adhesive, all of which were impact-tested in 0°C, 40°C and 80°C.[5)]

3. EXPERIMENTAL RESULTS AND CONSIDERATION

Fig.3 shows the result of impact test of the base material and the adhered materials in different temperature conditions, from which it is found that there was little scatter among 4 specimens each. As temperature in which test was carried out rose, impact value of the base material, the material adhered by hot curing type adhesive and the material adhered by cold curing type adhesive increased, almost unchanged and slightly increased, respectively. It should be noted specially that in 80°C the base material and the material adhered by cold curing type adhesive showed impact values of about 1.7 times as much of those in 20°C. Fig.4 shows adhesion joint efficiency of adhesives derived from the result of impact test in different temperature conditions. In 20°C, the material adhered by hot curing type adhesive showed 77% in joint efficiency, while the material adhered by cold curing type adhesive showed 40%, and it is apparent that hot curing type adhesive is superior. Approximation of adhesion joint efficiency in terms of impact strength is 70% and 40% with hot curing type and cold curing type respectively.

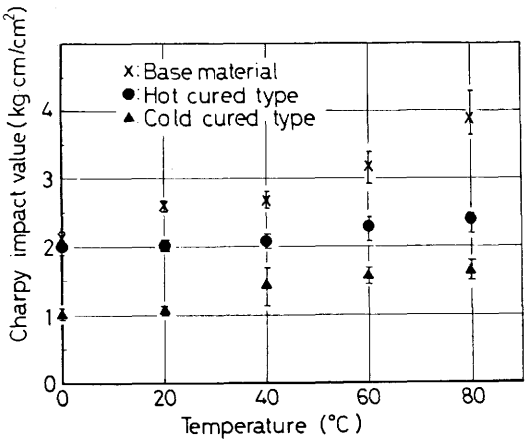


Fig.3 Experimental results of Charpy impact test for adhesion bonded dental P.M.M.A. at each temperature.

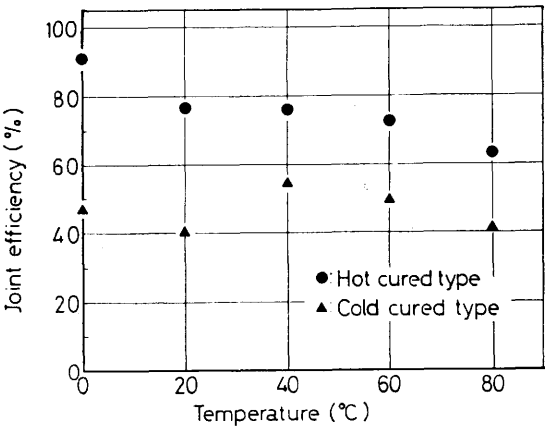
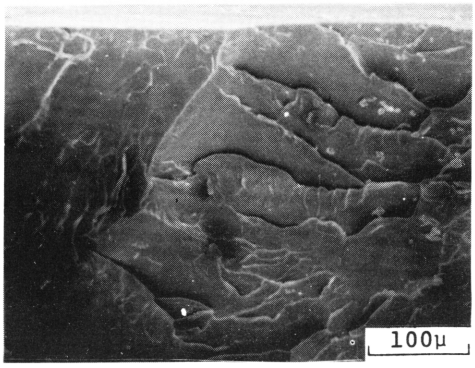
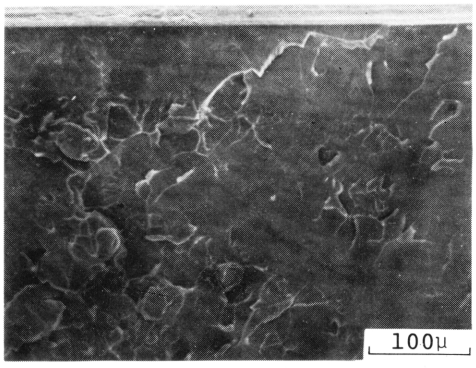


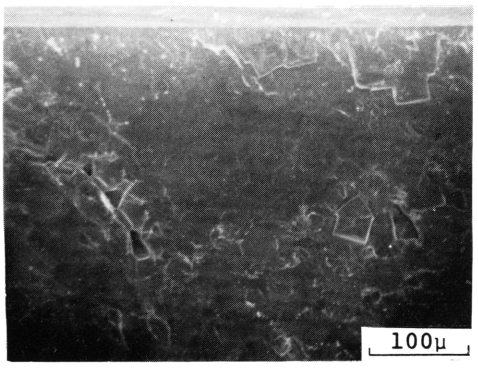
Fig.4 Charpy impact joint efficiency for adhesion bonded dental P.M.M.A. at each temperature.



(a) At 80°C

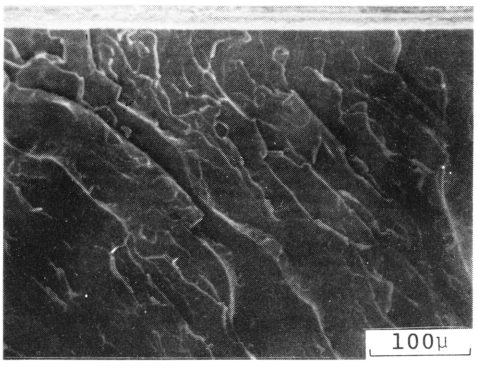


(b) At 40°C

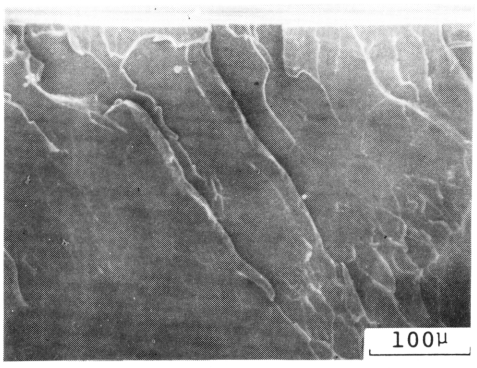


(c) At 0°C

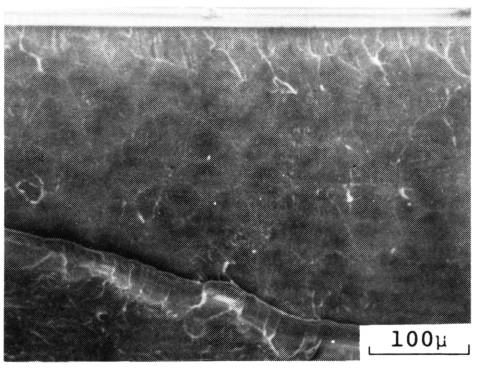
Photo.1 The appearances of impact fracture surfaces of dental P.M.M.A. in Charpy impact test at each temperature.



(a) At 80°C



(b) At 40°C



(c) At 0°C

Photo.2 The appearances of impact fracture surfaces of dental P.M.M.A. bonded by P.M.M.A. of hot curing type in Charpy impact test at each temperature.

Photo.1 shows pictures of impact fractures of the base material observed by scanning type electron microscope, from which it is known that as temperature rose the material broke with deformation, energy was absorbed upon breaking and fracture was ductile and had correlation with impact value. Photo.2 shows pictures of the material adhered by hot curing type adhesive, and shows similar result as in the case of the base material. Photo.3 shows the pictures of the material adhered by cold curing type adhesive, from which it is found that very little deformation took place even in 80°C, scar made by sand-paper during clearing process prior to adhesion was still observed on adhesion surface of specimens treated in 20-40°C, and the failure was breaking-away on adhesion interface and had correlation with impact value.

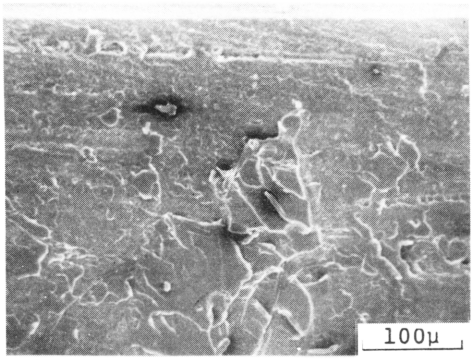
4. CONCLUSION

The following summary can be made from the results of the present research.

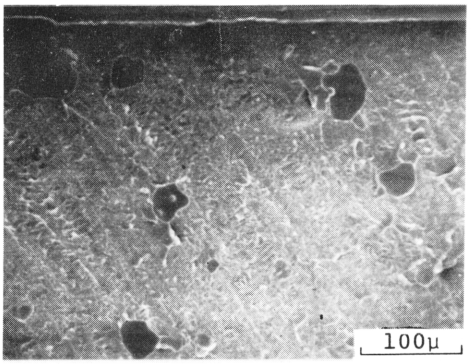
1) Scattering in impact value of adhered materials was little.

2) Impact strength increased as temperature of atmosphere rose.

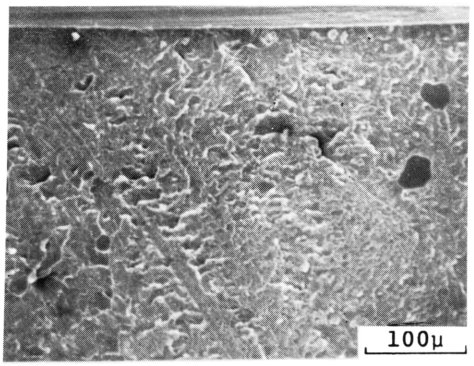
3) Approximation of adhesion joint efficiency in terms of impact strength was 70% and 40%



(a) At 80°C



(b) At 40°C



(c) At 0°C

Photo.3 The appearances of impact fracture surfaces of dental P.M.M.A. bonded by P.M.M.A. of cold curing type in Charpy impact test at each temperature.

with hot and cold curing types acrylic resin respectively, and dental hot curing type acrylic resin adhesive was superior.

4) Observation by scanning type electron microscope revealed that impact fracture of the base material and that of the material adhered by dental hot curing type acrylic resin adhesive were similar and that the breaking was ductile, while the failure of the material adhered by dental cold curing type acrylic resin adhesive was accompanying breaking-away on adhesion interfact.

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